CREDIT RISKS AND EUROPEAN GOVERNMENT BOND MARKETS: A PANEL DATA ECONOMETRIC ANALYSIS

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INTRODUCTION

Over the weekend of 1-3 May, 1998, European political leaders decided that 11 EU member states fulfilled the necessary conditions to adopt the Euro; i.e. all 15 EU member states except the United Kingdom, Denmark and Sweden, which had made clear that they did not wish to join at this stage, and Greece, which is judged not to meet all the necessary convergence criteria. European Economic and Monetary Union (EMU) is likely to have a major impact on European financial markets and the management of economic policies. The unique feature of EMU is that the fiscal authorities will remain at the national level, but the monetary authority will be transposed to a single federal European System of Central Banks (ESCB). Government bonds in EMU will be subject to default risk in stead of currency risk. The loss of monetary sovereignty — the right to print money — and the impossibility of devaluing the exchange rate exposes EMU national governments to sovereign risk [Goodhart, 1997a,b, 1998; Copeland, 1997]. EMU governments who have lost the ultimate control over their own central bank no longer can halt a process of declining bond prices and rising interest rates by monetising the debt. National government bond markets will be subject to liquidity crises, and not just solvency crises as now. Government bonds would mainly differ with respect to their creditworthiness, liquidity[1] and tax treatment[2], since intra-EMU exchange risk should be zero and inflation risk would be the same for every country in the Euro zone. Credit risks will replace market risks (caused by variations in interest rates and exchange rates) as the principal source of relative risk in government debt markets in EMU [IBCA, 1996].

Governments with above-average deficits and debt will find that they have less financial flexibility within EMU than currently is the case. Geographic labor mobility

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(and wage flexibility) within EMU is likely to be modest and Europe, in contrast to the United States, will have little potential to redress any regional inequalities through federal budget transfers [Goodhart, 1997a,b]. EMU member states will, however, retain considerable tax raising and spending powers.[3] Clearly, governments joining the monetary union will have to focus more on *fiscal* factors similar to those currently emphasized in the analysis of state or provincial governments in existing federal states.[4] What factors determine the fiscal flexibility of governments and thereby the market's perception of creditworthiness? To what extent will yields on long-term government bonds of EMU member governments diverge?

In the first half of 1998, long-term government bond interest rates of member states of the European Union (EU) have strongly converged to German long-term interest rates. Appendix A at the end of the paper plots 10-year benchmark government bond yield deviations of 12 EU member states vis-à-vis Germany over the period January 1987 to September 1998.[5] In the first half of 1998 (January 1998-June 1998) the average spread over German benchmark government bonds has converged to below 50 basis points in Austria (9), Belgium (14), Denmark (25), Finland (13), France (-3), Ireland (12), Italy (31), the Netherlands (2), Portugal (18), Spain (14) and Sweden (37).[6]

The average spread over the period January 1998-June 1998 was 89 basis points for the United Kingdom. The IMF in its 1997 Capital Markets Report attributes this convergence to

> ... the improved fundamentals (inflation and fiscal accounts) in peripheral countries. ... The renewed focus on EMU, and the increased likelihood that it will begin on schedule, have shifted expectations of the future path of fundamentals in the higher-yielding EU countries in close alignment with the criteria of the Maastricht Treaty. ... There is considerable consensus among market participants that these improvements in current and expected future fundamentals have been the primary driving force behind the convergence process, rather than extraneous factors such as excess liquidity. [IMF, 1997]

The IMF's 1998 Capital Markets Report noted: "Intra-European spreads against German bonds continued to decline, as expectations firmed of broad participation in the start of EMU." The recent Asian and Russian crises have, however, lowered the world's appetite for credit risk. The average spread over the period July 1998-September 1998 has increased to 23 for Austria, 28 for Belgium, 52 for Denmark , 33 for Finland, 8 for France, 24 for Ireland, 43 for Italy, 13 for the Netherlands, 39 for Portugal, 32 for Spain, 58 for Sweden and 98 for the United Kingdom. Notice that Denmark, Sweden and the United Kingdom — which did not wish to join in January 1999 — have average spreads of more than 50 basis points.

The paper is organized as follows. The following section first outlines a simple theoretical model for default risk and then presents an empirical measure to quantify the risk of government default. Default risk is measured by the *spread of 10-year benchmark government bond yields over the corresponding swap yield of the same 10-year maturity denominated in the same currency*. This measure is the dependent variable in our empirical analysis. This is a somewhat better measure of government default risk than that constructed by Alesina, De Broeck, Prati and Tabellini [1992]. Alesina et al. [1992] compare the return from holding government debt with the return from holding corporate debt denominated in the same currency. Alesina et al. [1992], however, apply a variety of different maturities for both public and private yields. For example, for Japan they compare the secondary market yield on interest-bearing 10-year government bonds (the public yield) with the secondary market yield on 12-year industrial bonds (the private yield). Differences in maturity between the public and private yields may lead to inaccurate measurement of the magnitude of government default risk. In addition, European governments increasingly finance their debt at longer maturities, and particularly at the 10-year horizon. The 10-year interest swap yield is therefore also a natural candidate with which to compare the 10-year benchmark government bond yields. Alesina et al. [1992] also include non-European countries (Australia, Canada, Japan and the United States) in their sample of 12 OECD countries, whereas we restrict the analysis to 13 EU member countries. Finally, and most importantly, the (private) risks entailed in interest rate swap yields are much less than the risks in the corporate bonds, as there is no principal at risk in an interest rate swap. Consequently, our measure for default risk is less sensitive to significant changes in private risk.[7] Our measure can also be seen as a somewhat more continuous (and obviously more time-varying) measure for default risk than the construction of indices of default risk based on credit ratings [Cantor and Packer, 1996a,b].[8]

The next section identifies common macroeconomic factors likely to affect government default risk and describes the econometric estimation technique. The econometric estimation technique chosen *a priori* allows for country heterogeneity. That is, we exploit the panel characteristics of our (unbalanced) data-set by estimating a one-way and two-way fixed effects model. The empirical analysis is initially carried out for a sample of 13 EU member countries over the period 1987-1996. We use a new data-set from the European Commission (DG2's AMECO database) in order to examine the determinants of government default risk. The AMECO database enables us to draw from the same database a variety of macroeconomic factors likely to affect the risk of government default. Furthermore, the definitions of the variables contained in the database comply with the official Maastricht Treaty [1992] definitions. In addition, we emphasize that the probability of default may depend both on the *level* and the *variability* of its determinants. The final section concludes the paper.

A MEASURE FOR DEFAULT RISK

An important motivation for our research in this area is the need to ascertain how much effect the fiscal stance of governments has on government default risk. Default risk or credit risk is the possibility — as expected by the market — that the issuer of a bond may be unable to make timely principal and/or interest payments.[9] Standard & Poor's [1998, 5] define default as the failure to meet a principal or interest payment on the due data (or within the specified grace period) contained in the original terms of the debt issue. Questions can arise, however, when applying this definition to different types of sovereign obligations. Standard & Poor's considers each sovereign issuer's debt in default in any of the following circumstances: (1) For local and foreign currency bonds, notes, and bills, when either scheduled debt service was not paid on the due date, or an exchange offer of new debt contained terms less favorable than the original issue; (2) For central bank currency, when notes were converted into new currency of less than equivalent face value; (3) For bank loans, when either scheduled debt service was not paid on the due date, or a rescheduling of principal and/or interest was agreed to by creditors.

Actual default by a sovereign country (especially among those sampled in this study) is highly unlikely. Nevertheless, great impacts will be exerted to the prices of bonds with a change in the perceived default risk associated with the issuing sovereign government [Kan, 1997, 1]. The estimation of default risk in this paper — which can be considered as the market equivalent of agencies' credit rating — allows us to extract the market's perceptions of government's default risk.[10] For example, the market might *expect* the government to be "unable" to raise sufficient tax revenues or to print money to meet scheduled coupon payments. This may lead to a fall in value of government bonds. Governments may find it hard to sell the government debt needed to finance the deficit in the market place because of supply-demand imbalances (liquidity shortage).

The main issue now is if the institutional design of EMU leads financial markets to discriminate between sovereign borrowers [Bishop, Damrau and Miller, 1989]. With a credible no-bailout clause (Maastricht Treaty) and credible penalties for breach of deficit rules (Stability Pact), financial markets should correctly price the risk of government default. Governments are then confronted with higher borrowing costs. Consequently, financial markets discipline profligate governments. Of course, the opposite scenario may hold if the no-bailout clause and the penalties are not credible.

Lamfalussy [1989] has argued that the fiscal stance of governments is often insufficiently reflected in credit risk premia. Expectations of a (partial) bailout — for example because of intra-European solidarity — might lead markets to misprice the risk of default and governments to embark on excessive debt accumulation.[11] The no-bailout clause in the Maastricht Treaty [1992] may possibly lead to (political) uncertainty about its role and implementation.[12] The IMF writes:

> Although the no-bailout clause in the Maastricht Treaty rules out the possibility of direct EU assistance to individual EU member countries, it is unlikely that market participants will price sovereign debt as if it were corporate debt. ... The mere size of public debt outstanding in any potential EMU member country relative to any single corporate issuer would imply significant systemic implications of an involuntary restructuring or an outright default by an EMU member country. ... This would increase the pressure to find alternative solutions. [1997, 192]

For example, to prevent systemic bank failures (because of banks holding large proportions of their own government's debt) and the financial dislocation arising from

government's threatened default on its Euro debt (with a threat of overspill onto other bond markets), the solvent members of the EMU might feel pressured to bail it out, e.g. by asking the European Central Bank (ECB) to buy the troubled government's bonds, or by direct government-to-government lending [McKinnon, 1995, 474].[13, 14] Expecting this *ex ante*, politicians in the errant country might become even less willing to take resolute fiscal action. It is important to note, however, that the Maastricht Treaty [1992] does not contribute a lender-of-last-resort role to the ESCB. This implies that the ESCB is not expected to inject liquidity into the system to deal with liquidity or insolvency crises of the banking system. It is yet to be determined how crises of this nature will be detected, monitored, and resolved [IMF, 1997, 180; European Monetary Institute, 1997a,b]. Although this arrangement may reduce moral hazard and enhance the credibility of the ECB it may be at odds with other functions of the ECB such as the smooth functioning of the payments systems [Schoenmaker, 1995/6].

Moreover, uncertainty about the practicality of the Stability Pact [1996], for example with respect to the method and feasibility of the imposition of sanctions for breach of deficit rules, affect market expectations and again might lead markets to misprice the risk of government default [Eichengreen and Wyplosz, 1998].[15] Others (such as Willem Buiter) stress the prudential rationale for the Stability Pact. The Stability Pact should reduce the danger of a bailout by preventing excessive exposure of banks and other financial institutions to government bonds.[16]

Next, this section outlines a simple theoretical model of government bonds with default risk and then presents an empirical measure to quantify the risk of government default. Previously it was argued that expectations of a (partial) bailout might lead markets to misprice the risk of government default.[17] To calculate the *expected return* on a bond that may possibly default, we need to take into account both the bond's probability of future default (the bond issuer's ability to make coupon and principal repayments as assessed by the market) and the percentage of the principal and coupon payments which holders can expect to recover in the case of default. The variables affecting default probabilities and recovery rates are indicated by $x_{j,t}$ and will be discussed in the next section.

Let us take a bond of 1, with a 1-year maturity. Let $i_{j,t}^{Risk\text{-}free}$ be the risk-free rate, $\theta(x_{j,t})$ the borrorower's one-year default probability as assessed by the market (which varies over time) and $RR(x_{j,t})$ bond's recovery rate. A risk-neutral investor will be indifferent about investing in "risky" government debt if

$$\theta(x_{j,t}) \cdot (1 + i_{j,t})\, RR(x_{j,t}) + [1 - \theta(x_{j,t})]\,(1 + i_{j,t}) = (1 + i_{j,t}^{Risk\text{-}free}) \tag{1}$$

where $i_{j,t}$ is the risky lending rate. After deriving $i_{j,t}$ from equation (1) we get:

$$i_{j,t} = [1 + i_{j,t}^{Risk\text{-}free}]/\{\theta(x_{j,t}) \cdot RR(x_{j,t}) + [1 - \theta(x_{j,t})]\} \tag{2}$$

Thus, unless $\theta(x_{j,t}) = 0$, and/or $RR(x_{j,t}) = 0$, it holds that $i_{j,t} > i_{j,t}^{Risk\text{-}free}$. If follows immediately upon differentiating that

$$\partial i_{j,t}/\partial\theta_j = [(1 - RR)(1 - i_{j,t}^{Risk\text{-}free})]/\{[\theta_j RR + (1 - \theta_j)]^2\}$$

and

$$\partial i_{j,t}/\partial RR = [-\theta_j(1 + i_{j,t}^{Risk\text{-}free})]/\{[\theta_j RR + (1 - \theta_j)]^2\} < 0.$$

Governments' borrowing costs increase with the probability of default and decrease with the loan's recovery rate.

Since the risky interest rate is now the government bond yield, we have to find another reference rate to compare with the "risky" government bond yield.[18]

Credit risk of sovereign debt can be assessed in a synthetic way by comparing yields on domestic government bonds with high-quality private risk represented by interest rate swap yields [Giavannini and Piga, 1994; Favero, Giavazzi and Spaventa, 1996; IMF, 1997; McCauley, 1996; Eijffinger, Huizinga and Lemmen, 1998].The yield on the fixed income side of a plain vanilla interest rate swap $i_{j,t}^{Swap}$ is substituted for the risk-free rate $i_{j,t}^{Risk\text{-}free}$. The swap rate represents the rate paid by the fixed-rate party in return for receiving the variable interest rate.[19] Thus, we compare the public credit risk entailed in government bond yields with the private credit risk as reflected in the swap rate, thereby measuring the *relative* credit risks in both markets.[20] Narrower spreads $i_{j,t} - i_{j,t}^{Swap}$ indicate more risky government debt since government debt yields are usually below swap yields [McCauley, 1996, 30]. A less negative value of the spread implies here greater government default risk since the credit risk of prime banks, or corporations, is assumed not to vary greatly from currency to currency, so that fluctuations in the differential between the public sector debt rate and the fixed swap rate are assumed primarily to reflect shifts in the credit risks of the public sector. The *key* assumption in this paper is that the credit risk of prime banks or corporations does not vary greatly from currency to currency [McCauley, 1996, 30; Favero, 1998], so that fluctuations in the differential between the public sector debt rate and the fixed swap rate primarily reflects shifts in the credit risks of the former. The major banks post interest rate swap yields in a variety of currencies.

Our measure cannot distinguish between credit risk and liquidity risk.[21] We assume that variations in yield differentials stem from credit risks and that variations in liquidity are negligible. Yet, liquidity effects may play a central role in the determination of yields in government bond markets. Whereas it may be fair to assume that our determinants of countries' credit risk will remain "constant" in the short run (following the start of EMU), liquidity, however, is certainly an *endogenous* variable [Alogoskoufis, Portes and Rey, 1997, 27]. The respective importance of liquidity and credit risk variations can therefore be of prime importance for our conclusions.[22] Because of the lack of data on the volume of benchmark government bond issues this aspect unfortunately has to be left for future research. Similarly, bond issues of two otherwise identical credit risks may be priced differently if issuing techniques, clearing and settlement procedures, and legal procedures are different. The introduction of the Euro will provide incentives to governments to lower financing costs further by increasing transparency and by improving issuing techniques and financial infrastructures to attract investors. This competitive process could lead to the sufficient

harmonization of market practices within the Euro zone and could eliminate the advantages that a particular geographical market may now have [IMF, 1997, 185].[23]

Our measure also assumes that variations in the credit risk of a given government bond do not "spill over" in the swap market with respect to the same country. If that is the case our measure underestimates the variation in credit risk (controlling for liquidity). Similarly, if private credit risk has an impact on public credit risk our measure overestimates the variation of credit risk of a given government bond.

The relevant swap rate to compare with the benchmark government bond yield is the offer rate for receiving a fixed rate.[24] For the European currencies DATASTREAM quotes the all-in cost (the internal rate of return or yield to maturity) of the fixed-side of the swap outright [Alworth, 1993, 14]. So, the default risk measure is defined here as the annualized redemption yield on the domestic government bond less the offer rate on the fixed-income side of the interest rate swap.[25] Ideally, the withholding tax effect also has to be disentangled from the default risk measure [Favero, 1998].[26] Eijffinger, Huizinga and Lemmen [1998] concluded that nonresident interest withholding taxes on foreign source interest income of U.S. and Japanese investors were fully reflected in pre-tax government bond interest rates. However, the interest withholding tax effect is extremely hard to quantify as it depends, among other things, on the availability of a domestic tax credit for taxes paid on foreign-source interest income, the existence of a double taxation treaties, market power, and the administrative burden of reimbursement [Norregaard, 1997]. Consequently, this paper abstracts from any attempt to assess the nonresident interest withholding tax effect on pre-tax government bond yields. Our observation period (1987-1996) largely coincides with a period in which most exchange controls on capital flows in the EU were lifted. Consequently, we also abstract from the role of capital controls.

In our empirical analysis, we will initially focus on 13 EU member countries for which relevant data are available: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom (see Table B.1 in Appendix B). Daily data for 10-year benchmark government bonds yields and interest rate swap offer yields are taken from DATASTREAM. Subsequently, monthly averages of daily data were calculated. We adjust for market conventions in government bond and swap markets. The compounding basis for benchmark government bonds and swap rates is annual. Coupon payments are usually made annually, but in Ireland, Italy and the United Kingdom they are made semiannually. These and other cross-country variations in market conventions highly complicate return comparisons and may considerably affect the size of our default risk measure.[27] So, each observation is carefully adjusted for differences in market conventions in the government bond and the interest rate swap markets. Table B.2 in Appendix B summarizes existing market conventions for the benchmark government bond markets. Similarly, Table B.3 in Appendix B summarizes the existing market conventions in the interest rate swap markets.

Appendix C plots the default risk measure $i_{j,t} - i_{j,t}^{Swap}$ over the period January 1987-June 1997. Generally, government default risks in Europe have been small in magnitude. Appendix C shows that the swap yield usually exceeds the domestic benchmark government bond yield as government debt is perceived as less risky than private debt. Only for Italy, and for short periods for Belgium, Portugal and Spain, has the spread at times been positive. For the other EU countries, the measure has been consistently negative. Apparently, Italy has been seen by the markets to have had a relatively large risk of default. For all EU countries except for Sweden (-36 basis points) and the United Kingdom (−56 basis points), the average spread measured over the period January 1998-June 1998 between government bond redemption yields and the offer yield on interest rate swaps has ranged from −12 (Italy) to -30 basis points (France). McCauley and White [1997, 9] also have documented this. Apparently, not only inflation and exchange risks but also default risks as assessed by the market have converged.[28] In the aftermath of the Asian and Russian crises the average spread measured over the period July 1998-September 1998 between government bond redemption yields and the offer yield on interest rate swaps has ranged from -14 (Italy) to -93 basis points (United Kingdom).

THE DETERMINANTS OF GOVERNMENT DEFAULT RISK

Next, we discuss some of the main factors that differentiate between credit quality among sovereign governments. That is, we assess the factors that determine governments' *ability* and *willingness* to service its debt [Cantor and Packer, 1996b, 253]. Many factors believed to be related to government default risk have been advanced in the literature [OECD, 1995; Cantor and Packer, 1996a, 1996b; Eichengreen and von Hagen, 1996b; European Commission, 1997]. We summarize these factors in six categories.[29] We propose the following theoretical explanations and empirical indicators $x_{j,t}$ that affect the risk of government default $\theta(x_{j,t})$ and the bond's recovery rate $RR(x_{j,t})$ (see also Table D.1 of Appendix D):

Governments' Tax Raising Capability

The first explanation involves determining the specific taxes and intergovernmental revenues available to the government, as well as obtaining historical information on tax collection rates, and the dependence of general government budgets on specific revenue sources. Also the mobility of household and corporate tax bases in response to tax rises is important [Eichengreen and von Hagen, 1996b].Taxation can replace printing money as means of raising funds to repay debt service obligations. We apply the variable *TAXCAP* — measured as the difference between the highest level of general government current receipts over the period 1960-1996 less present current receipts as a percentage of gross domestic product at market prices — in our empirical analysis. The higher taxable capacity, that is the higher the margin for tax increases, the less likely the government is to default.[30] Greater awareness of the distortionary and employment-dampening effects of high taxation as well as voters' resistance have made many governments reluctant to introduce further tax increases.[31] To be fair, it should be said that this variable is still based on realized outcomes.

Governments' Ability to Control Spending

This category involves identifying the dependence of general governments' budgets on specific expenditure outlays. We employ the variable *EXP*— general government total current expenditures excluding interest payments as a percentage of gross domestic product at market prices. Higher (historical) levels of current expenditures excluding interest payments are expected to increase the risk of default.

Governments' Debt Management Policies

This category assesses the debt-related characteristics of the bond issuer. The category consists of indicators on the issuers' debt structure.[32] A possible candidate determinant is *DEBT* — general government consolidated gross debt according to the Maastricht definition as a percentage of gross domestic product at market prices. High existing debt to GDP ratios and concomitant debt service obligations hamper the governments' capacity to borrow, roll over debt etc. and increase the risk of default.

The Degree of Federal Support

Federal grant and aid programs, and revenue sharing arrangements will affect the ability of governments to meet their obligations and/or affect the funds available. The "federal" budget amounts to about 1.25 percent of EU GDP in 1995. So, the effect of federal grants and aid programs is rather modest in the EU [Goodhart, 1997b].

The Capacity of the Political System to Produce Coherent Governments

This category relates to the issuer's ability and political discipline for maintaining sound budgetary operations [von Hagen, 1992]. The focus here is usually on the political conditions that affect a country's creditworthiness. Note that the fixed-effects estimator employed in this paper cannot estimate the effect of any time-invariant variable like indices of the number of significant government changes, the political leaning of the government, union participation, etc. For example, governments often choose to avoid the political consequences of increased tax rates. This category is partly taken into account by the variability of inflation $VINF_{-1}$ (see below).

The Governments' Socioeconomic Environment

This last general category is an assessment of the issuer's overall socioeconomic environment. Fundamental changes in the economy may cause economic hardship for governments and thus difficulty in meeting their obligations. Potential relevant indicators are INF_{-1} (lagged inflation measured as the annual percentage change in the log of the consumer price index) and INF_{-1} (lagged inflation variability measured as the absolute deviations of data points from their mean). The government will benefit from higher (unanticipated) inflation. Higher inflation increases government seigniorage revenue and lowers the real value of debt which lowers the prospect of government default. Uncertainty about the level of inflation may however lead to an inflation premium incorporated in the nominal interest rate. This may increase debt service payments and consequently is expected to have a positive effect on the risk of government default.

To overcome problems of reverse causation we use one-period lagged inflation and inflation variability. Furthermore, lagged inflation and inflation variability may also overcome possible multicollinearity between debt ratios which may be positively associated with higher inflation (we will calculate cross-correlation coefficients of the explanatory variables). The endogeneity problem — where the explanatory variable in the regression may be correlated with the stochastic error term that captures all other determinants of government default risk — especially arises in time–series analysis but may also arise in cross–section analysis. The fiscal variables *TAX CAP* and *EXP* in the regression, however, are less prone to the endogeneity problem since as a share of *GDP* they hardly change over time. Credit risks in government bond markets and *DEBT* may be a function of the state of the business cycle and other common factors such as shocks in world interest rates. Both credit risk and *DEBT* are known to be higher during recessions. Therefore, the determinants of government default risk are also estimated over two consecutive 5-year time intervals, 1987-1991 and 1992-1996, in order to see if the endogeneity problem arises. Furthermore, by splitting the sample period into two 5-year time intervals and because the data used to calculate our government default risk measure have a remaining 10 years to maturity — we know that the data over the period 1992-1996 refer to government bonds and interest rate swap contracts that mature beyond the date of 1 January 1999. It is important to realize that the type of government default risk before 1999 (default because of monetary financing in national currency) differs from the type of government default risk after 1999 (default because the government is unable to pay interest and/or principal in Euro). In EMU, an inflationary debt bailout is highly unlikely. Finally, note that *DEBT* is also included by Alesina et al. [1992].[33] The variables TAX CAP, EXP, INF_{-1}, $VINF_{-1}$ are introduced here.

The time-series properties of the data were also examined in order to test for a unit root in the explanatory variables (Augmented Dickey-Fuller tests).[34] The null hypothesis of non-stationarity could not be rejected for *TAX CAP* and *DEBT* but was rejected for lagged inflation INF_{-1}. Since estimation requires stationarity, non-stationary variables are entered in first differences (indicated by Δ).

Next, we turn to the estimation of the model. To refine our econometrics we will exploit the panel characteristics of our data. We apply a one-way fixed-effects model (with individual country effects that are constant over time) and a two-way fixed effects model (with individual country effects that are constant over time *and* time-effects that are constant over countries). The default risk measure is the dependent variable and above listed factors are the independent variables.

The following general specification for the one-way fixed effects model for the default risk measure can be postulated [Hsiao, 1986, 29-32; Baltagi, 1995, 10-3]:

$$(i - i^{Swap})_{j,t} = \beta_0 + \beta' x_{j,t} + \gamma_j + \epsilon_{j,t} \qquad (3)$$

where subscripts $j = 1,..,N$ represent the countries in our sample, subscript $t = 1,..,T$ is the time subscript, coefficient β_0 is the common intercept representing an EU common market-wide level of default risk, $\beta = (\beta_1, \beta_2, \beta_3, \beta_4, \beta_5)'$ are the coefficients for the explanatory variables $x_{j,t} = (\Delta DEBT_{j,t}, \Delta EXP_{j,t}, \Delta TAX\,CAP_{j,t}, \Delta INF_{j,t-1}, \Delta VINF_{j,t-1})'$ of the default risk measure $(i_{j,t} - i^{Swap}_{j,t})_{j,t}$, γ_j is the country-specific effect representing country-specific default risk and $\epsilon_{j,t}$ is the error term for country j in period t.[35] We comprise the common intercept β_0 and the country-specific effect γ_j together to ζ_j. Appendix E describes the derivation of the within-group estimator of the one-way fixed-effects model. Basically, the one-way fixed-effects model implies that all countries have the same coefficients for the explanatory variables but that the intercepts vary across countries. We also estimate a two-way fixed effects model. In the two-way fixed-effects model, we allow for separate β coefficients of the explanatory variables for two consecutive 5-year time intervals (1987-1991 and 1992-1996) to see whether the β coefficients change over time.[36]

Our data set consists of an unbalanced panel of 13 or 12 EU member countries (excluding Italy) over the period 1987-1996. The reason for doing so is that simple observation shows that Italy is an outlier, with a much larger and more variable spread. The number of observations over the period 1987-1996 ranges from a minimum of 4 monthly observations (Ireland) to a maximum of 116 monthly observations for Germany and the United Kingdom (see Tables B.1 and B.3 in Appendix B). Data relate to the *general government* which consists of the central, state, local and the quasi-public sector. Sovereign risk is not limited to central government debt but also encompasses debt contracted by the state, local and quasi-public sector and all other debt with a government guarantee. From 1991 onwards, data for Germany refer to a unified Germany as constituted from 3 October 1990.

The results when applying one-way and two-way fixed-effects estimations to an unbalanced panel of 13 EU countries over the period 1987-1996 are summarized in the first half of Table 1 (regressions 1-3).[37] The second half of Table 1 (regressions 4-6) summarizes the results when applying one-way and two-way fixed-effects estimations to an unbalanced panel of 12 EU countries (excluding Italy). In regressions 1-2 and 4-5 a one-way fixed-effects model is estimated while in regressions 3 and 6 a two-way fixed-effects model is estimated. Before arriving at the specification incorporated in regressions 1 and 4, we did undertake preliminary studies of the effects of other variables, such as the variability of debt, the first difference of exports of goods and services to GDP, the first difference of imports of goods and services to GDP and growth measured as the percentage change in the log of the industrial production index excluding construction. Estimating over equations with and without Italy helps to reveal which relationships are reasonably robust. Although in some cases there were indications of significant relationships, the results from these preliminary studies were not robust when run across the two samples, with and without the inclusion of Italy. In particular, we were suspicious of apparently significant results in the sample including Italy, which ceased to be significant or changed sign in the EU-12 sample.

Tables D.2. and D.3 in Appendix D report Pearson cross-correlation coefficients of the explanatory variables for the sample of 13 and 12 EU countries, respectively. Debt ratios are strongly positively correlated with the expenditure excluding interest payments ratios ($\rho = 0.4867$ for the EU-13 and $= 0.5127$ for the EU-12 sample). Consequently, we excluded ΔEXP from the analysis.

Regressions 2 and 5 include a time dummy (T_{1994}) to account for the 1994 bond market decline and resulting increased bond market volatility [Borio and McCauley,

TABLE 1
The Determinants of Government Default Risk

	1	2	3	4	5	6
$\beta_{\Delta DEBT}$	0.0151 [0.0026]**	0.0138 [0.0026]**		0.0114 [0.0023]**	0.0100 [0.0023]**	
$\beta_{INF,\ 1986\text{-}1995}$	−0.0718 [0.0075]**	−0.0751 [0.0071]**		−0.0752 [0.0071]**	−0.0769 [0.0068]**	
$\beta_{VINF,\ 1986\text{-}1995}$	0.0405 [0.0134]**	0.0412 [0.0133]**		0.0345 [0.0137]**	0.0349 [0.0136]**	
$\beta_{\Delta TAX\ CAP,\ 1987\text{-}1996}$	−0.0337 [0.0088]**	−0.0249 [0.0080]**		−0.0048 [0.0054]	−0.0053 [0.0052]	
T_{1994}		−0.1174 [0.0217]**			−0.0817 [0.0166]**	
$\zeta_{Austria}$	−0.0642 [0.0295]**	−0.0546 [0.0281]*	−0.0763 [0.0318]**	−0.0499 [0.0255]*	−0.0440 [0.0248]*	−0.0777 [0.0281]**
$\zeta_{Belgium}$	0.0444 [0.0216]**	0.0769 [0.0211]**	0.0338 [0.0239]	0.0663 [0.0208]**	0.0867 [0.0208]**	−0.0400 [0.0234]*
$\zeta_{Denmark}$	−0.2302 [0.0259]**	−0.1906 [0.0209]**	−0.2284 [0.0271]**	−0.2068 [0.0242]**	−0.1812 [0.0208]**	−0.2238 [0.0265]**
$\zeta_{Finland}$	−0.4320 [0.0517]**	−0.4220 [0.0498]**	−0.3965 [0.0554]**	−0.3879 [0.0465]**	−0.3835 [0.0458]**	−0.3796 [0.0495]**
ζ_{France}	−0.3389 [0.0230]**	−0.3033 [0.0247]**	−0.3411 [0.0238]**	−0.3060 [0.0220]**	−0.2812 [0.0230]**	−0.3093 [0.0233]**
$\zeta_{Germany}$	−0.1627 [0.0262]**	−0.1391 [0.0262]**	−0.1600 [0.0284]**	−0.1396 [0.0258]**	−0.1242 [0.0260]**	−0.1616 [0.0303]**
$\zeta_{Ireland}$	−0.0392 [0.0379]	−0.0427 [0.0376]	−0.0413 [0.0443]	−0.0547 [0.0354]	−0.0633 [0.0352]*	−0.1090 [0.0384)**
ζ_{Italy}	0.8146 [0.0652]**	0.8615 [0.0613]**	0.7888 [0.0683]**			
$\zeta_{the\ Netherlands}$	−1.1028 [0.0230]**	−0.0775 [0.0228]**	−0.0912 [0.0292]**	−1.1039 [0.0241]**	−0.0870 [0.0233]**	−0.1448 [0.0312]**
$\zeta_{Portugal}$	−0.0127 [0.0687]	0.0084 [0.0677]	0.0209 [0.0779]	0.0344 [0.0695]	0.0453 [0.0689]	0.0014 [0.0807]*
ζ_{Spain}	−0.0003 [0.0412]	0.4215 [0.0400]	−0.0148 [0.0451]	0.0382 [0.0394]	0.0666 [0.0383]	0.0097 [0.0462]
ζ_{Sweden}	−0.4545 [0.0399]**	−0.4110 [0.0399]**	−0.4327 [0.0427]**	−0.4032 [0.0395]**	−0.3732 [0.0389]**	−0.4193 [0.0441]**
$\zeta_{United\ Kingdom}$	−0.2998 [0.0454]**	−0.2721 [0.0440]**	−0.2743 [0.0451]**	−0.2724 [0.0451]**	−0.2549 [0.0445]**	−0.2763 [0.0471]**
$\beta_{\Delta DEBT,\ 1987\text{-}1991}$			0.0455 [0.0168]**			−0.0433 [0.0356]*
$\beta_{\Delta DEBT,\ 1992\text{-}1996}$			0.0139 [0.0027]**			0.0077 [0.0018]**
$\beta_{INF,\ 1986\text{-}1990}$			−0.0853 [0.0108]**			−0.0897 [0.0109]**
$\beta_{INF,\ 1991\text{-}1995}$			−0.0629 [0.0087]**			−0.0608 [0.0084]**
$\beta_{VINF,\ 1986\text{-}1990}$			0.0797 [0.0222]**			0.0405 [0.0218]*
$\beta_{VINF,\ 1991\text{-}1995}$			0.0170 [0.0157]**			0.0239 [0.0159]**
$\beta_{TAX\ CAP,\ 1987\text{-}1991}$			−0.0014 [0.0202]			−0.0638 [0.0247]**

TABLE 1 (Cont.)
The Determinants of Government Default Risk

	1	2	3	4	5	6
$\beta_{TAX\ CAP,\ 1992\text{-}1996}$			−0.0420 [0.0108]**			0.0046 [0.0064]
S.E. of regression	0.2149	0.2113	0.2142	0.1825	0.1804	0.1808
F-test for fixed effects (p-value)	122.4830 (0.0001)	125.6307 (0.0001)	97.6492 (0.0000)	39.4939 (0.0001)	37.1326 (0.0001)	38.1563 (0.0001)
F-test for equality of fixed effects (p-value)	116.4300 (0.0001)	124.0209 (0.0001)	90.9633 (0.0001)	30.0807 (0.0001)	30.8980 (0.0001)	17.1411 (0.0001)
White hetero-skedasticity test (p value)	299.413 (0.0000)	331.682 (0.0000)	306.069 (0.0000)	279.335 (0.0000)	310.965 (0.0000)	163.599 (0.0000)
Hausman test of H_0: RE vs. FE (p-value)	$\chi^2(4)$= 8.3139 (0.0807)	$\chi^2(5)$= 8.5419 (0.1288)	$\chi^2(8)$= 14.680 (0.0657)	$\chi^2(4)$= 8.4810 (0.0755)	$\chi^2(5)$= 8.4810 (0.1316)	$\chi^2(8)$= 13.796 (0.0872)
Adj. R^2	0.6904	0.7007	0.6925	0.4666	0.4783	0.4763
N	729	729	729	660	660	660

S.E. is the standard error of the regression, Adj. R^2 is the coefficient of determination adjusted for degrees of freedom, N indicates the number of usable observations. Figures are calculated to 4 decimal places. Heteroskedasticity-consistent White (1980) standard errors are indicated in square brackets. The following EU countries (subscript j) are included in regressions 1-3: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. The following EU countries (subscript j) are included in regressions 4-6: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

1 and 4: $(i - i^{Swap})_{j,\ 1987\text{-}1996} = \zeta_{Austria} + \dots \zeta_{United\ Kingdom} + \beta \Delta DEBT_{j,\ 1987\text{-}1996} + \beta INF_{j,\ 1986\text{-}1995} + \beta VINF_{j,\ 1986\text{-}1995} + \beta TAX\ CAP_{j,\ 1987\text{-}1996} + \epsilon_{j,\ 1987\text{-}1996}$

2 and 5: $(i - i^{Swap})_{j,\ 1987\text{-}1996} = \zeta_{Austria} + \dots \zeta_{United\ Kingdom} + \beta \Delta DEBT_{j,\ 1987\text{-}1996} + \beta INF_{j,\ 1986\text{-}1995} + \beta VINF_{j,\ 1986\text{-}1995} + \beta TAX\ CAP_{j,\ 1987\text{-}1996} + \beta T_{1994} + \epsilon_{j,\ 1987\text{-}1996}$

3 and 6: $(i - i^{Swap})_{j,\ 1987\text{-}1996} = \zeta_{Austria} + \dots \zeta_{United\ Kingdom} + \beta \Delta DEBT_{j,\ 1987\text{-}1991} + \beta DEBT_{j,\ 1992\text{-}1996} + \beta INF_{j,\ 1986\text{-}1990} + \beta INF_{j,\ 1991\text{-}1995} + \dots + \beta VINF_{j,\ 1986\text{-}1990} + \beta \Delta VINF_{j,\ 1991\text{-}1995} + \beta TAX\ CAP_{j,\ 1987\text{-}1991} + \beta TAX\ CAP_{j,\ 1992\text{-}1996} + \epsilon_{j,\ 1987\text{-}1996}$

* indicates that the coefficient is significantly different from zero at the 95% level of confidence (two-tailed test).

** indicates that the coefficient is significantly different from zero at the 99% level of confidence (two-tailed test).

Source: See Appendices B and D.

1995]. Finally, regressions 3 and 6 report the results of the two-way fixed-effects model of regressions 1 and 4 with separate β coefficients of the explanatory variables for two consecutive 5-year time intervals (1987-1991 and 1992-1996).

For the within-group estimator Baltagi [1995, 12-3] advises a simple method for obtaining robust estimates of the standard errors that allow for a general variance-covariance matrix of the $\epsilon_{j,t}$ as in White [1980].[38] Table 1, therefore, reports heteroskedasticity-consistent White [1980] standard errors in square brackets.[39] A fixed effects model may suffer from a large loss of degrees of freedom and too many dummies may aggravate the problem of multicollinearity among the regressors. However, in the fixed effects models estimated in this paper N, the number of countries is 13 (or N=12 excluding Italy) and the sample size is 729 (or 660 excluding Italy), leaving sufficient degrees of freedom in estimation.

We also test for the joint significance of the fixed effects. In all cases, the F-test on the *absence* of fixed effects is strongly rejected. In addition, the F-test for the *equality* of the fixed effects is also strongly rejected in all regressions. So, long-term government bond yield spreads within EU have been persistent reflecting differences in cross-country government default risk. Finally, we report the Hausman [1978] specification test based on the differences between the fixed effects (FE) and random effects (RE) estimator which, marginally, cannot reject the random effects model in regressions 1-6. The ensuing estimation of a random-effects model, however, did not yield different estimation results in terms of the sign and magnitude of the estimated β coefficients.[40]

Regressions 1, 2 and 3 show that the parameters are correctly signed and give a reasonably good explanation of the risk of government default (Adj. R^2). As expected, in regressions 1, 2 and 3, inflation ($INF_{j,t-1}$) and the first difference of taxable capacity ($\Delta TAX\ CAP_{j,t}$) are found to significantly reduce the risk of government default. Government default risk is found to increase significantly with the first difference of the debt to GDP ratio ($\Delta DEBT_{j,t}$) and the variability of inflation ($\Delta VINF_{j,t}$). Similar to Alesina et al. [1992], the effect of changes in debt ratios is positive and strongly significant. The market and credit rating agencies will have to focus increasingly on the "fiscal flexibility" of a member state as measured by its taxable capacity, persistence in debt levels, etc. We find a significantly negative 1994 time dummy of −0.1174 (with a White [1980] standard error of 0.0217) in regression 2. This significant negative time-dummy suggests that private risks strongly exceed public risks during this period of bond turbulence.

Positive (or less negative) fixed effects coefficients indicate relatively higher default risks. The ranking of EU countries in terms of the size of the country dummy variable in an ascending order with respect to regression 1 is: Sweden, Finland, France, United Kingdom, Denmark, Germany, the Netherlands, Austria, Ireland, Portugal, Spain, Belgium, Italy. The ranking of Sweden and Finland may well have been affected by larger private sector risks resulting from the banking crisis in these years in these countries, thereby making our maintained assumption invalid. What is otherwise surprising is the apparently worse ranking of Germany relative to France and the United Kingdom. The ranking in the other regressions remains much the same.

The results for the two-way fixed-effects estimation for the sample of 13 EU countries indicate that changes in debt to GDP have a positive effect on default risk in both subperiods. Inflation reduces government default risk in the both subperiods but to a lesser extent in the second subperiod. The variability of inflation has a positive effect on default risk in both subperiods, with a smaller effect over the period 1991-1995. Taxable capacity reduces the risk of government default in both subperiods. Its effect is stronger and significantly negative in the second subperiod.

We next consider the sample without Italy. Among the determinants of default risk in regressions 4 and 5, taxable capacity ($\Delta TAX\ CAP_{j,t}$) is now *insignificantly* negatively associated with default risk, contrary to the result for the EU-13 sample where $\Delta TAX\ CAP_{j,t}$ was found to have a significantly negative effect on default risk.[42] The magnitude and the sign of coefficients in front of the other explanatory variables $\Delta TAX\ CAP_{j,t}$, $\Delta INF_{j,t-1}$, $\Delta VINF_{j,t-1}$ and T_{1994} are comparable with regressions 1 and 2. The two-way fixed-effects panel regression 6 shows $\Delta DEBT_{j,t}$ has changed from having a negative effect on default risk in the subperiod 1987-1991 to having a significant positive effect on default risk in the period 1992-1996 contrary to regression 3 where $\Delta DEBT_{j,t}$ has always a significantly positive effect on default risk. $\Delta TAX\ CAP_{j,t}$ in regression 6 is significantly negatively associated with default risk over the period 1987-1991 and insignificantly negatively associated with default risk over the period 1992-1996, contrary to $\Delta TAX\ CAP_{j,t}$ over the period 1992-1996 in regression 3.

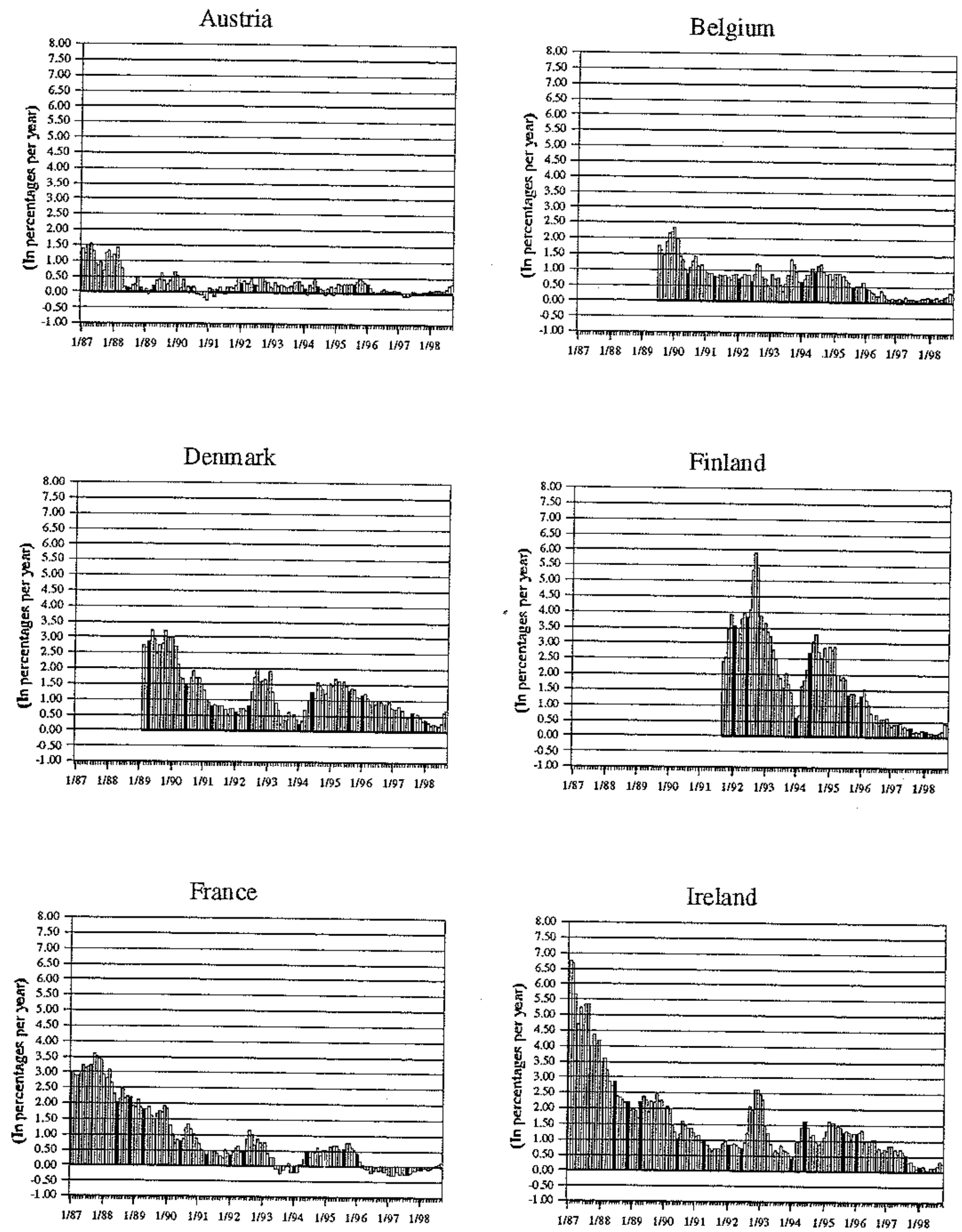
We do not have any good behavioral explanation of these changes in sign and significance, and such lack of robust relationships weakens our conclusions. Nevertheless the role of Italy as an outlier, and the fact that we are dealing with an unbalanced panel in which data availability varies between countries, may have been partially responsible. Thus, during the first subperiod, 1986-1990, there is only one year of Italian data, and only the observations for Germany and the United Kingdom are available over the whole sample period, 1987-1996. Another explanation for these varying results may be the fact that we have assumed that the country-specific risk factors are constant over time, which of course may not hold. Finally, note that empirical identification often has to come from the cross-sectional differences since $\Delta DEBT_{j,t}$, and $\Delta TAX\ CAP_{j,t}$ only change gradually over time.

CONCLUSIONS

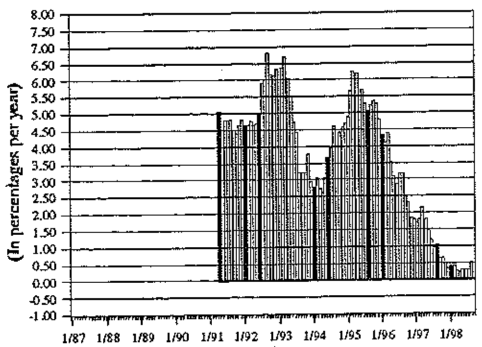
Building on the work of Alesina et al. [1992], we seek to explain public/private sector yield differentials by variables that measure the size of the government and allow for both the volatility as well as the level of determinants to enter the preferred specifications. With respect to the EU-13 and EU-12 sample we have found government default risk to depend positively on $\Delta DEBT_{j,t}$ and $VINF_{j,t-1}$ and negatively on $INF_{j,\tau-1}$ and $\Delta TAX\ CAP_{j,t}$. These three new explanatory variables $VINF_{j,t-1}$, $INF_{j,t-1}$, and $\Delta TAX\ CAP_{j,t}$ contribute to a better explanation of government default risk itself. Differences in factors such as $\Delta DEBT_{j,t}$ and $\Delta TAX\ CAP_{j,t}$ will not suddenly disappear in 1999 [see also European Commission, 1997]. Many macroeconomic variables only adjust gradually. Public sector receipts and expenditure historically average somewhat over 40 percent of GDP in most EU countries. We also reject the null hypothesis of the equality of country-specific fixed effects. Bond yield differentials are expected to continue within EMU, despite evidence that government bond yield differentials vis-à-vis Germany have narrowed sharply recently (at least until the Asian and Russian crises). The market is likely to come to distinguish between government bond yields, particularly for the longer-term debt. McCauley and White [1997, 9] correctly argue that a single unified yield on government bonds denominated in the Euro would require accepting a "joint and several liability" of the EMU member states for each other's debt and government debt of different countries would have to be perfectly substitutable.

Of course, all the results have to be interpreted with caution. Government default risks in Europe have been small in general. EU countries have enough taxable capacity and spending is being cut down. In addition, the model is severely affected by the Lucas critique since the 1 January 1999 can be considered to be a regime shift. We don't know what is going to happen with the model parameters after 1999. Although an improvement to the one used by Alesina et al. [1992], the default risk measure still has several problems. A first problem is that uncertainty about government debt service will affect private sector risks particularly when banks or other financial institutions hold large proportions of their assets in government debt, leading private and public risks to move in a lockstep fashion. Future research should gain a more in-depth knowledge of the link between government default risk and the vulnerability of banks (financial stability) [Arnold, 1998]. A second problem is that the default risk measure also introduces a variety of national factors other than government default that may well interact with the explanatory variables [Obstfeld, 1992].Therefore, future research efforts should rely on the comparison of federal and provincial debt yields *within* existing federal states where this is less of a problem. Large differentials between provincial and federal debt yields might imply that financial markets discipline governments and government bond yield differentials in EMU will remain persistent [Bayoumi, Goldstein, Woglom 1995; Ganley, 1997]. A third problem is that we apply government bond redemption yield data. The use of redemption yields introduces coupon reinvestment risks in our default risk measure. The redemption yield depends on the coupon size. To our knowledge, however, zero coupon bond yields are not available in DATASTREAM. I would like to refer here to Krogstrup [1998] who calculates zero coupon equivalent spot rates using a bootstrapping method. A final problem is that one may want to distinguish between countries that are (likely) to join at the first stage (also with regard to its political commitment) and countries that are not. For example, at the end of 1997 Italy was more and more expected to enter EMU at the first stage. Accordingly, Italy's long-term government bond yields converged to the German long-term government bond yield.

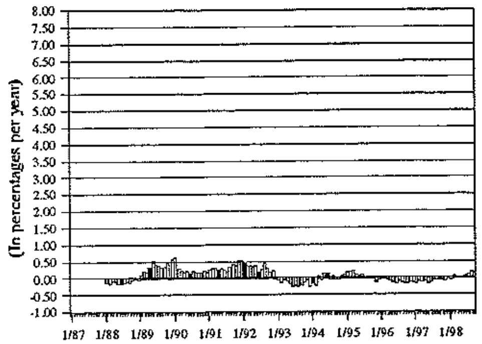
Appendix A
Deviations of 10-year Benchmark Government Bond Yields Vis-A-Vis Germany



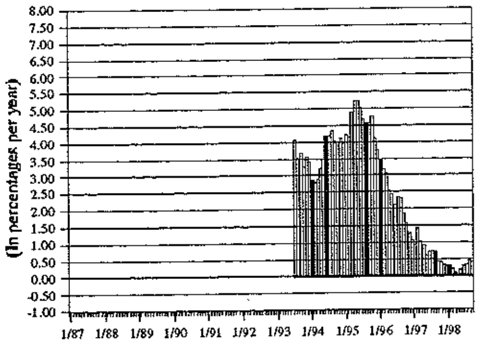
Italy



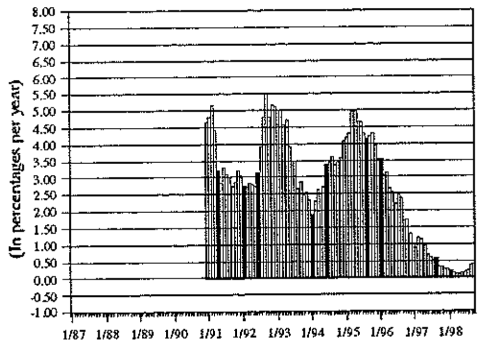
The Netherlands



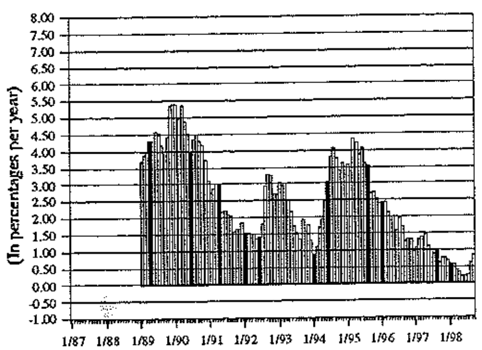
Portugal



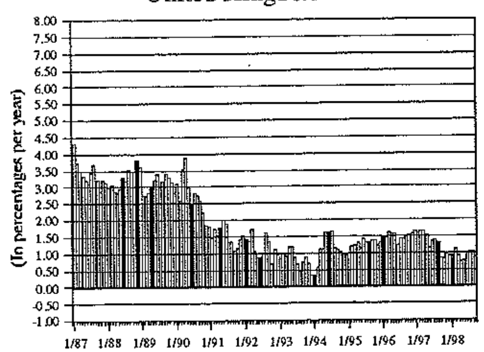
Spain



Sweden



United Kingdom



Appendix B
The Dependent Variable

TABLE B.1
EU Countries and Their Sample Period

Country	Sample period	Country	Sample period
Austria	01/31/95-09/30/98	Italy	04/30/91-09/30/98
Belgium	06/28/91-09/30/98	Netherlands	06/28/91-09/30/98
Denmark	02/28/93-09/30/98	Portugal	11/15/94-09/30/98
Finland	06/30/95-09/30/98	Spain	01/31/91-09/30/98
France	06/28/95-09/30/98	Sweden	01/31/92-09/30/98
Germany	04/30/87-09/30/98	United Kingdom	04/30/87-09/30/98
Ireland	08/06/96-09/30/98		

TABLE B.2
Market Conventions in Government Bond Markets

Country	P/Y	Settlement period in days	Day count basis	Ex-Dividend period	Yield metho-dology	Coupon payment frequency	Fixing days
Austria	CP%	3	30/360	Circa 3-4 wks	RY	Norm. 1	2
Belgium	CP%	3	30/360	Nil	RY-MMY	1	2
Denmark	CP%	3	30/360	30 cal. days	RY[5]	Norm.. 1	Same or 2
Finland	Y	3	30/360	Nil	RY-MMY	Norm. 1	2
France	CP%	3	Actual/Actual	Nil	RY-MMY	1	1
Germany	CP%	2 (Int.3)	30/360	Nil	RY-MMY	Norm. 1	?
Ireland	CP%	1	Act/365	Wednesday 3 weeks prior to coupondate (6)	RY	2	Same
Italy	CP%	3	30/360+ 1 day(1)	Nil	RY	Norm. 2	2
Nether-lands	CP%	3	30/360	Nil	RY	Norm. 1	2
Portugal	CP%/CP(7)	4 (Int 3)	30/360	Nil	RY (8)	Norm. 1	2
Spain	CP%	5 (2)	Actual/Actual	Nil	RY-MMY(3)	Norm.1	Same
Sweden	Y	3	30/360	5 cal. days	RY	Norm. 1	2
United Kingdom	CP%	1	Actual/365	7 wkg. days	RY	Norm. 2	Same

CP%	Clean percentage price, to which accrued interest is added.
Y	Normally quoted on yield basis.
P/Y	Price/Yield quotation method.
RY-MMY	ISMA redemption yield until the last coupon period, when a money market yield is used.
30/360	Accrues on a 360-day year with the 31th being treated as the 30th.
Actual/Actual	Accrues on actual days in period.
Actual/365	Accrues on actual days in period/Accrues on a 365 day year

TABLE B.2 (Cont.)
Market Conventions in Government Bond Markets

1. The number of days accrued include both the last coupon date and the settlement date, i.e. it is one more day than the norm.
2. A reduction to three business days is being considered.
3. The yields are compounded with fractional periods being calculated as actual days/365, although bonds accrue interest on an actual/actual basis.
4. The semi-annual coupon accrues according to the number of calendar days in the period.
5. If the coupon data is between the 10^{th} and 24^{th} of month, then the ex-dividend data is the first Monday of month after the first day of the month, otherwise it is the first Monday after the 14^{th} of the month.
6. If coupon pays on Saturday or Sunday, assume coupon pays on following Monday and therefore Wednesday 3 weeks prior.
7. Treasury bonds are priced domestically as a price per bond, to which accrued interest has to be added.
8. Yields are compounded with fractional periods being calculated as actual days/365, although bonds accrue interest on a 30/360-day basis.

Irish, Italian and UK benchmark government bond yields are annualized according to the following formula: $(1 + \text{annual yield}/100) = (1 + \text{semi-annual yield}/200)^2$. Furthermore, we assume that the benchmark government bonds in France and Spain accrue interest on 365-day year, and 366 if there is a leap year. Consequently, benchmark government bond yields of France and Spain are converted to a 360 day year by multiplying by 360/365 or 360/366. Source: London Investment Banking Association [1997] and DATASTREAM.

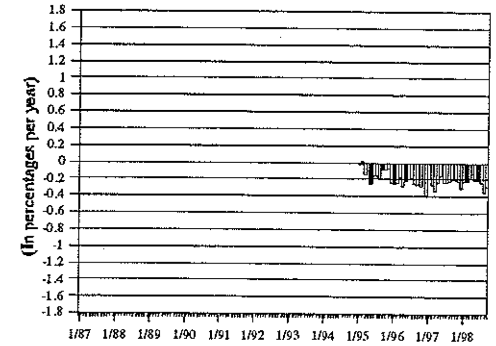
TABLE B.3
Market Conventions in the Interest Rate Swap Market

Country	Fixed day count basis	Fixed payment frequency	Floating payment frequency	Sample period
Austria	30/360	Annual	Semi-Annual	01/31/95-09/30/98
Belgium	Act/365	Annual	Semi-Annual	06/28/91-09/30/98
Denmark	30/360	Annual	Semi-Annual	02/28/93-09/30/98
Finland	30/360	Annual	Semi-Annual	06/30/95-09/30/98
France	30/360	Annual	Semi-Annual	06/28/95-09/30/98
Germany	30/360	Annual	Semi-Annual	04/30/87-09/30/98
Ireland	Act/365	Semi-Annual	Semi-Annual	08/06/96-09/30/98
Italy	30/360	Annual	Semi-Annual	04/30/91-09/30/98
The Netherlands	30/360	Annual	Semi-Annual	06/28/91-09/30/98
Portugal	30/360	Annual	Semi-Annual	11/15/94-09/30/98
Spain	30/360	Annual	Semi-Annual	01/31/91-09/30/98
Sweden	30/360	Annual	Semi-Annual	01/31/92-09/30/98
United Kingdom	Act/365	Semi-Annual	Semi-Annual	04/30/87-09/30/98

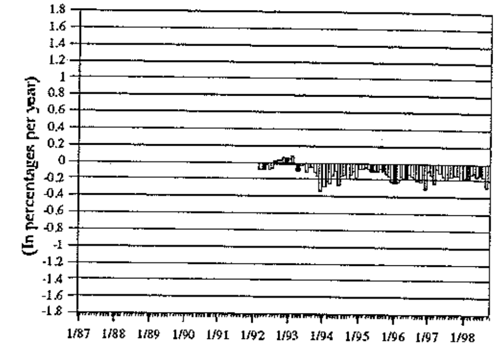
Ireland and the UK interest rate swap yields are annualized according to the following formula: $(1 + \text{annual yield}/100) = (1 + \text{semi-annual yield}/200)^2$. Interest rate swap yields of Belgium, Ireland and the United Kingdom are converted to a 360 day year by multiplying by 360/365 or 360/366. The length of the sample period for each country is determined by the availability of interest rate swap yield data. Source: DATASTREAM.

APPENDIX C
The Measure of Government Default Risk in 13 EU Countries

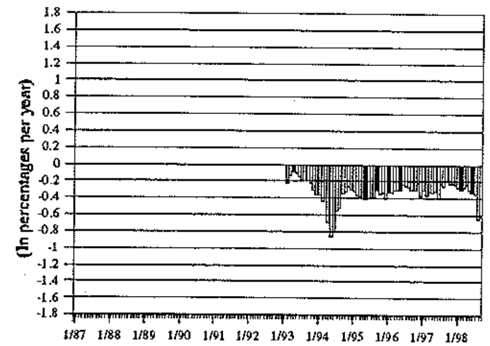
Austria



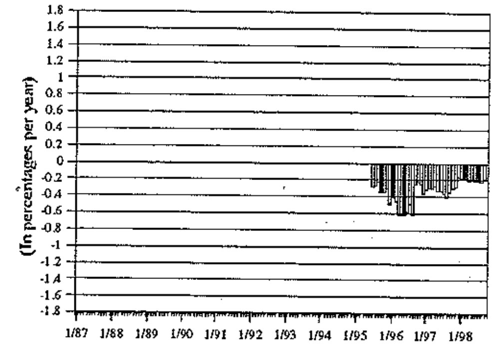
Belgium



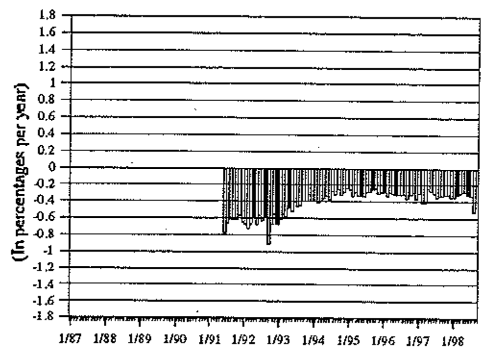
Denmark



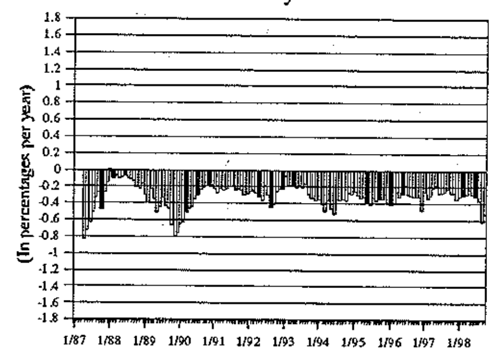
Finland



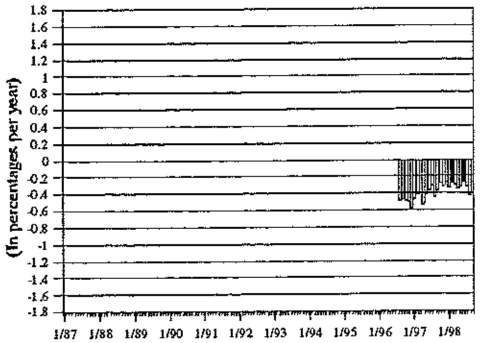
France



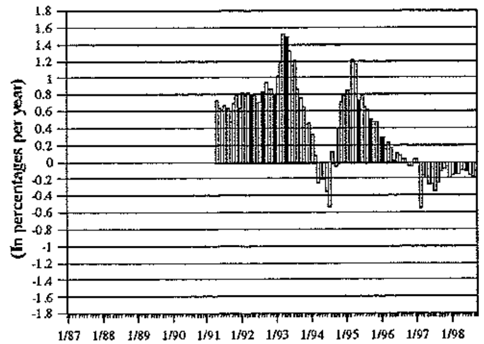
Germany



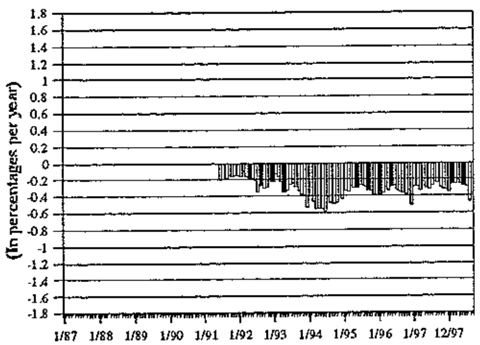
Ireland



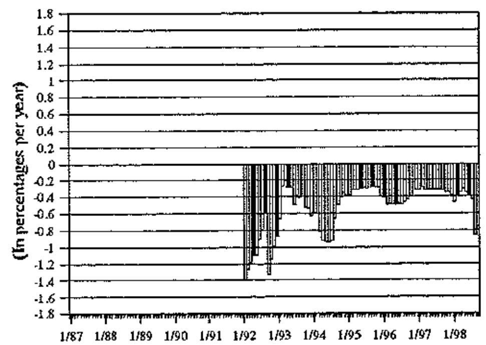
Italy



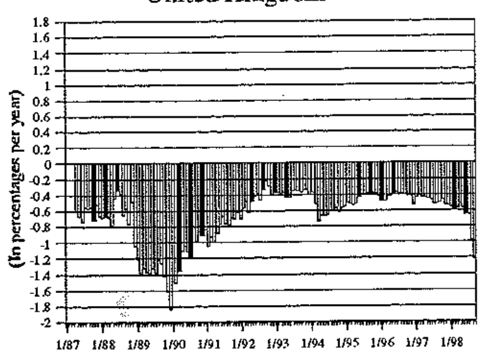
The Netherlands



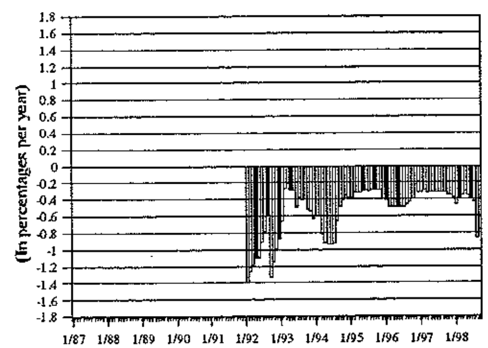
Sweden



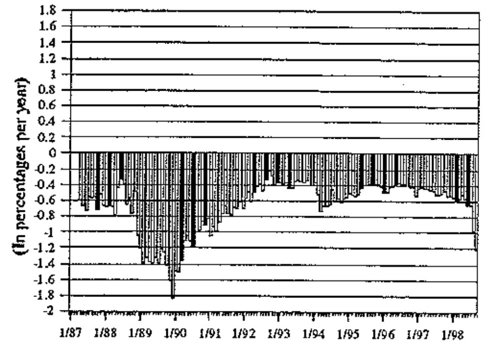
United Kingdom



Sweden



United Kingdom



APPENDIX D
The Independent Variables

TABLE D.1
The Explanatory Variables

DEBT:	General government consolidated gross debt according to the Maastricht definition as a percentage of gross domestic product at market prices. Source: European Commission, DG2, AMECO
EXP :	General government total current expenditures excluding interest payments as a percentage of gross domestic product at market prices. Higher (historical) levels of current expenditures excluding interest payments are expected to increase the risk of default. Source: European Commission, DG2, AMEÇO
INF:	Inflation measured as the annual percentage change in the consumer price index (1991=100) Source: European Commission, DG2, AMECO
TAX CAP:	Taxable capacity measured as the difference between the highest level of general government current receipts over the period 1960-1996 less present current receipts as a percentage of gross domestic product at market prices. Source: European Commission, DG2, AMECO

TABLE D.2
Correlation Analysis:
Pearson Correlation Coefficients
(13 EU Countries)

	ΔEXP	ΔTAX CAP	INF_{-1}	$VINF_{-1}$
ΔDEBT	0.4865	– 0.0598	0.2877	0.0071
	(0.0001)	(0.1065)	(0.0001)	(0.8480)
ΔEXP		– 0.2567	0.3397	0.2531
		(0.0001)	(0.0001)	(0.0001)
ΔTAX CAP			0.0635	–0.1375
			(0.0865)	(0.0002)
INF_{-1}				0.3912
				(0.0001)

The Pearson correlation t-test statistic is defined as $t_\rho = (n-2)^{1/2} / (n-\rho^2)^{1/2}$ where ρ is the Pearson correlation coefficient and n is the number of observations. P-values under H_0: $\rho = 0$ / $N = 729$ are between parentheses.

TABLE D.2
Correlation Analysis:
Pearson Correlation Coefficients
(12 EU Countries)

	ΔEXP	ΔTAX CAP	INF_{-1}	$VINF_{-1}$
ΔDEBT	0.5127 (0.0001)	0.0167 (0.6682)	0.2498 (0.0001)	−0.0197 (0.6134)
ΔEXP		− 0.1776 (0.0001)	0.3904 (0.0001)	0.2521 (0.0001)
ΔTAX CAP			0.1448 (0.0002)	− 0.1068 (0.0060)
INF_{-1}				0.3877 (0.0001)

The Pearson correlation t-test statistic is defined as $t_\rho = (n-2)^{1/2} / (n-\rho^2)^{1/2}$ where ρ is the Pearson correlation coefficient and n is the number of observations. P-values under H_0: $\rho = 0 / N = 660$ are between parentheses.

APPENDIX E
The Derivation of the Within-Group Estimator

Below, we briefly describe the derivation of the within-group estimator. For convenience, we introduce the following matrix notation:

$$(i - i^{Swap})_j = [(i - i^{Swap})_{j,t}, \ldots, (i - i^{Swap})_{j,T}]' \; j = 1, \ldots, N$$

$$\zeta_j = (\beta_0 + \gamma_j) \quad j = 1, \ldots, N$$

$$X_j = (x_{j,1}', \ldots, x_{j,T}')' \quad j = 1, \ldots, N$$

$$e = (1, \ldots, 1)'$$

$$e = (\epsilon_{j,1}, \ldots, \epsilon_{j,T})' \quad j = 1, \ldots, N$$

Note that we have comprised the common intercept β_0 and the country-specific effect γ_j together to ζ_j. This is because both terms are fixed constants we cannot identify or estimate them separately. The conditions for $\epsilon_{j,t}$ imply for $\epsilon_{j,t}$:

(a) $$E(\epsilon_j) = 0 \qquad j = 1, \ldots, N$$

(b) $$E(\epsilon_j, \epsilon_j') = \sigma^2 I_T \qquad j = 1, \ldots, N$$

(c) $$E(\epsilon_i, \epsilon_j') = 0 \qquad i, j = 1, \ldots, N \wedge i \neq j.$$

Now equation (3) in the text can be written as:

(4) $$(i - i^{Swap})_j = \zeta_j e + X_j \beta + \epsilon_j \qquad j = 1, \ldots, N$$

Define matrix Q as $Q = I_T - ee'/T$ where I_T denotes the identity matrix with dimensions T by T. Premultiplying equation (4) with Q has the effect of transforming all observations into deviations of their individual means. Performing this transformation on equation (4) gives:

(5) $$Q(i - i^{Swap})_j = QX_j \beta + Q\epsilon_j \qquad j = 1, \ldots, N$$

Since transforming a constant into a deviation of its individual mean gives zero, the term $\zeta_j e$ drops out. Applying ordinary least squares (OLS) to equation (5) gives the following within-group estimator [Hsiao, 1986, 31):

(6) $$\hat{\beta}_{WG} \left(\sum_{j=1}^{N} X_j' Q X_j \right)^{-1} \left(\sum_{j=1}^{N} X_j' Q (i - i^{Swap})_j \right)$$

Now we can estimate ζ_j for each j by:

(7) $$\zeta_{j,WG} = \overline{(i - i^{Swap})}_j - \overline{X_j'} \hat{\beta}_{WG}$$

with

$$\overline{(i - i^{Swap})}_j = \frac{1}{T} \sum_{t=1}^{T} (i - i^{Swap})_{j,t}$$

and

$$\overline{X_j} = \frac{1}{T} \sum_{t=1}^{T} X_{j,t}$$

The variance-covariance matrix of the within-group estimator is

(8) $$\widehat{VAR}(\beta_{WG}) \sigma_\epsilon^2 \left(\sum_{j=1}^{N} X_j' Q X_j \right)^{-1}$$

with

$$\sigma_\epsilon^2 = \frac{1}{NT - N - k} \sum_{j=1}^{N} \left[(i - i^{Swap})_j - \zeta_{j,WG} e - X_j \hat{\beta}_{WG} \right]' \left[(i - i^{Swap})_j - \zeta_{j,WG} e - X_j \hat{\beta}_{WG} \right]$$

and

$$\widehat{VAR}(\zeta_{j,WG}) = \overline{X_j'} \widehat{VAR}\left(\hat{\beta}_{WG} \right) \overline{X_j} + \frac{\sigma_\epsilon^2}{T}$$

The parameter k denotes the number of regressors. Furthermore, under proper conditions with respect to the error term we can apply OLS to equation (5) and the within-group estimator is BLUE (Best Linear Unbiased Estimator) [Hsiao, 1986, 32]. The generalized country-specific effects represent the relative magnitudes of default risk per country. So, we expect countries with more default risk to show more positive (or less negative) coefficients for the generalized country-specific effect. The $\beta = (\beta_1, \beta_2, \beta_3, \beta_4, \beta_5)'$ coefficient for the explanatory variables then represents the *common* reaction of the EU sample to X_j.

NOTES

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1. Pieterse-Bloem [1997, 52] mentions also other considerations such as name recognition and investors' preferences. Kan [1997] argues that the spread mainly reflects differences in the nature of the issuers and their settlement system, i.e. *quality spreads*. Prati and Schinasi [1997, 13] argue: "Credit risk is likely to be the most important component of securities pricing within EMU, with the implication that the 'relative value' of underlying credits will drive securities prices rather than judgements about the stability and volatility of currency values." Merrill Lynch [1997, 9] states: "The introduction of private pension plans across continental Europe over the next few years, the disappearance of European cross-exchange risk, the shrinking of government markets as public-debt ratios fall, and a general search for yield as fixed-income volatility and returns decline, will all act to turn investors' attention to credit in the coming years." "Credit will increasingly become the driving force of returns in domestic and global portfolios."
2. Lemmen [1998b, 47-50] analyzes the pros and cons of a new proposal for a EU-wide minimum withholding tax on savings in the form of interest payments to individuals ahead of the launch of the Euro on January 1, 1999.
3. EMU member states should be able to service higher debt loads than American states and Canadian provinces, because of greater ability of EMU member states to adjust their own expenditures and revenues and because of the *lower* mobility of the tax bases involved [Eichengreen and von Hagen, 1996a, 135].
4. In the United States and Canada, the risk-free rate $i_{j,t}^{Risk\text{-}free}$ usually is the federal government borrowing rate, while state or provincial governments pay a premium $rp_{j,t}$ over the federal borrowing rate [Branson, 1990]. Governments will borrow at a rate equal to: $i_{j,t} = i_{j,t}^{Risk\text{-}free} + rp_{j,t}$. However, in EMU, given its small supranational fiscal power and balanced budget requirement, federal debt will be too small for a liquid federal government bond market to develop. Therefore, the risk-free rate is likely to be taken as either the yield on French or German government debt paper [Deutsche and Siedenberg, 1997; Dalles and Mackintosh, 1997; European Commission, 1997a].
5. For Greece and Luxemburg benchmark government bond indices are not available. The composition of each government debt market differs considerably. By comparing yields on benchmark government bonds indices collected from DATASTREAM we avoid choosing from a wide variety of government bond instruments in each country [Battley, 1997]. The *benchmark* (the latest or "on the run") government bond is the most liquid government debt security traded in the market against which

other debt securities (e.g. corporate or provincial) are priced. However, note that the size and thus liquidity of the benchmark issues of government bonds also varies considerably across countries: from US$ 1-2.5bn in countries like Portugal, Sweden and Austria, to almost US$ 20bn in France [Pieterse-Bloem, 1997, 47]. The 10- year class of bonds is considered to be the representative class of long-term bonds in the majority of EU countries.

6. At the end of 1997 it became clear to the market that Italy, Portugal and Spain would enter EMU from the first wave [Favero, 1998].
7. Of course, this may not always hold for every country. Sweden, for example, had much higher private risks than public risks during the banking crisis of 1991-1992.
8. Moreover, Liu and Thakor [1984] have found that yield spreads are not solely guided by credit ratings.
9. The different nature of default risk in EMU is reflected in how credit rating agencies rate government bonds. The rating of domestic currency debt is often higher than that of foreign currency debt.
10. In Appendix C we show that the government default spread may vary dramatically over time. Credit ratings of government bonds are often held constant over long periods of time.
11. Article 104b of the Maastricht Treaty [1992] states: "The Community shall not be liable for or assume the commitments of central governments, regional, local or other public authorities, other bodies governed by public law, or public undertaking of any Member State, without prejudice to mutual financial guarantees for the joint execution of a specific project." The same provision applies to individual EU countries.
12. Of course, the nature of a bailout in EMU differs fundamentally from the nature of a bailout in an existing federal state where the federal government may bail out one of its *own* state governments. Of course, the nature of a bailout in EMU differs fundamentally from the nature of a bailout in an existing federal state where the federal government may one of its *own* state governments.
13. Note that pension funds also hold large amounts of government bonds.
14. Indeed, this topic is also relevant for banking regulators. Goodhart [1997a] indicates that zero risk weightings for government paper is no longer appropriate for Stage 3 of EMU.
15. The Stability Pact [1996] narrows down the definition of the "exceptional and temporary circumstances under which countries can escape penalties if they run an excessive deficit." A member state will be exempted from penalties for deficits of more than 3 per cent of GDP in the event of a natural disaster or if its economy shrinks by more than 2 per cent in a year. For recessions where output drops by 0.75 per cent to 2 per cent, countries must justify to their partners the need for leniency. The imposition of a fine would thus be subject to a *political* judgement if there was a recession of more than 0.75 per cent of GDP. The European Council meeting of the EU finance ministers held in Amsterdam on 5-6 April 1997 agreed in principle on the general framework for the sanctions mechanism for breach of the Stability Pact [1996]. The sanctions will start as a non-interest deposit equal to 0.2 percent of GDP, plus one-tenth of the deficit exceeding the 3 per cent ceiling. The deposits will be limited to 0.5 per cent of GDP and be converted to a fine after two years if the government continues to overspend [Mohamed, 1997, 352].
6. Arnold [1998] analyzes the link between banks' exposure to government debt and the stability of the European financial system.
17. This model captures the basic message of the paper by Duffie and Singleton [1997]. See also Gawronski [1997], Gilibert [1997, 49-50] and Rolf [1996, 54].
18. Our default risk measure reverses the usual perspective, which treats government debt as the "risk-free" asset and the spread as a measure of private sector risk. Our default risk measure is basically the long-term equivalent of the short-term onshore-offshore interest differential. However, the swap rates also incorporate *counterparty risk* and therefore swap rates are not completely risk-free in the strict sense.
19. A typical plain vanilla interest rate swap involves one party, the floating payer and fixed receiver, making payments linked to a floating interest rate such as the six-months London interbank offer rate (LIBOR), which is reset periodically over the life of the swap, while the other, the fixed payer and the floating receiver, will make payments linked to a known fixed interest rate set initially for the life of the swap [Alworth, 1993, 13-4]. The maturity and the notional principal on which the interest payments are based are identical for both legs of the swap and no actual exchange of principal at inception or maturity takes place [Alworth, 1993, 14]. Therefore, there is no principal at risk.

20. Interestingly, it is possible to calculate the default probability $\theta(x_{j,t})$ from equation (1) assuming the bond's recovery rate $RR(x_{j,t})$ to be zero.
21. We abstract from factors such as the transparency of the market, the availability of derivatives contracts, expertise etc. [see Dattels, 1995].
22. For example, in EMU, the EC matching rule — governing the investment practices of insurance companies and pension funds requiring that 80 percent of liabilities be matched by assets denominated in the same currency — will no longer confine local investors to domestic issuers.
23. The elimination of exchange risk and its costs, the convergence of credit spreads, and more uniformity in market practices together can be expected to increase the depth and liquidity of European government bond markets.
24. The fixed rate payer (and floating rate receiver) is said to have purchased the swap (or "gone long") whereas the floating rate payer (and fixed rate receiver) is said to have sold the swap (or "gone short").
25. The interest rate swap market for government bonds is highly competitive and the bid/ask spreads have fallen to 4 basis points (e.g with respect to France and Germany) and 5 basis points (e.g. with respect to Italy and Spain) (Source: Own calculations with bid and offer swap yields taken from DATASTREAM).
26. The yield net of withholding tax for the funds obtained in the domestic market depends on the bond yield and the withholding tax rate paid at source, for example: $i_t \times (1-\tau)$. No withholding tax is levied on swap contracts.
27. Recently, the European Commission [1997] — following the proposals of the London Investment Banking Association [1997] — recommended a set of harmonized market conventions for new Euro-denominated instruments.
28. This decline in credit risks did not only occur in European government bond markets. Large declines in credit risk have, for example, occurred in the junk bond market and the Latin American government bond markets.
29. Of course, the weight attached to each category and each factor should be empirically estimated.
30. Because of growing economic and financial integration in Europe and concomitant tax competition [Lemmen, 1998a], the historical maximum for a particular country is probably not attainable anymore. Possibly, the deviation of the tax burden in a EU country from the average EU tax burden is a better measure for taxable capacity.
31. Future research might want to take into account the specific measures taken by governments to change the size and structure of taxation and expenditures such as privatization, decentralization to sub-national governments, the commercialization of public bodies and the compensation of government employees. [OECD, 1995].
32. Unfortunately, the AMECO database lacks data on the debt term structure. Though important, we necessarily have to leave this for future research.
33. Alesina et al. [1992] also include the average debt maturity as an explanatory variable. Unfortunately, the European Commission's DG2 AMECO database lacks this information. Though important, we necessarily have to leave this aspect for future research. Krogstrup [1998] includes the ratio of short-term debt to total debt (SHORT) as an explanatory variable in the regression (available for Belgium, Denmark, France and Spain, obtained from national sources). The parameter estimate for SHORT is not significantly different from zero, although it is positive which is the expected sign.
34. The results are available from the authors.
35. We assume the error term $\epsilon_{j,t}$ to be an independently, identically distributed random variable with mean zero and variance . Furthermore, we assume that the error term is independent of the regressors. Moreover, when we use F- and t-statistics, we implicitly make the assumption that the error term is normally distributed.
36. The ignorance of individual and time effects might possibly lead to efficiency losses and biased inference.
37. All estimations in this paper are realized with TSP 4.3A.
38. The assumption of heteroskedasticity-consistent White [1980] standard errors is necessary for the validity of econometric inferences.
39. OLS standard errors are of similar magnitude to White [1980] standard errors.
40. The results for the random effects estimations are available from the authors.
41. The sample of 13 EU countries is arguably a more balanced sample of EU countries including both countries with high and low government default risk.

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